Sec 2: DSP

~~systems~~

a) $y(n) = n\,x(n)$

$x_1(n) \longrightarrow n\,x_1(n)$

$x_2(n) \longrightarrow n\,x_2(n)$

$x_1(n) + x_2(n) \longrightarrow n(x_1(n) + x_2(n)) = y_1 + y_2$

$\longrightarrow$ Linear

$\rightarrow$ output depends only on present i/p $\rightarrow$ static

$\longrightarrow$ o/p doesn't depend on future i/p $\rightarrow$ Causal

* $y(n,K) = n\,x(n-K)$

$y(n-K) = (n-K)\;x(n-K)$

$y(n-K) \neq y(n,K) \longrightarrow$ shift variant

$\longrightarrow$ unstable system.

$\rightarrow$ input multiplied with n

b) $y(n) = a\, x(n)$

→ Linear

→ static

→ Causal

→ shift-invariant.

→ stable

c) $y(n) = x(n^2)$

→ $x_1(n) \longrightarrow x_1(n^2)$

$x_2(n) \longrightarrow x_2(n^2)$

$x_1(n) + x_2(n) \longrightarrow \underbrace{x_1(n^2) + x_2(n^2)}_{y_3} = y_1 + y_2$

* Dynamic. $y(5) = y(25)$

Future

* non-Causal.

* $\left.\begin{array}{l} y(n,K) = x(n^2-K) \\ y(n-K) = x((n-K)^2) \end{array}\right\} \neq \Rightarrow$ shift variant

* stable

$$y(n) = x(n) + 3u(n+1)$$

$$y_1(n): x_1(n) \longrightarrow x_1(n) + 3u(n+1)$$

$$y_2(n): x_2(n) \longrightarrow x_2(n) + 3u(n+1)$$

$$x_1(n) + x_2(n) \longrightarrow x_1(n) + x_2(n) + 3u(n+1)$$

$\longrightarrow y_3(n) \neq y_1(n) + y_2(n)$ non-linear

$\longrightarrow$ Dynamic, non-causal.

$$\Rightarrow y(n,K) = x(n-K) + 3u(n+1)$$

$$y(n-K) = x(n-K) + 3u(n-K+1)$$

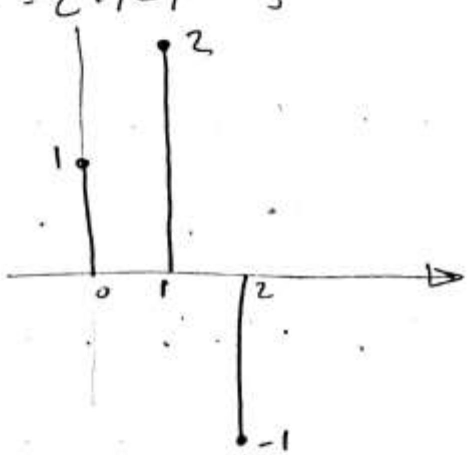
$y(n,K) \neq y(n-K) \longrightarrow$ shift variant

$\longrightarrow$ stable system

Convolution

$$y(n) = \sum_{K=-\infty}^{\infty} x(K) \cdot h(n-K)$$

* $x(n) = \{1, 2, -1\}, \; h(n) = \{1, 2, -1\}$



__n = 0__

$$y(0) = \sum_{0}^{2} x(K)\, h(-K)$$

$$= x(0)h(0) + \cancel{x(1)h(-1)} \to 0$$

$$+ x(2)\cancel{h(-2)} \to 0$$

$$y(0) = 1$$

__n=1__ $y(1) = \sum_{0}^{1} x(K)\, h(1-K)$

$$= x(0)\, h(1) + x(1)\, h(0) = 2 + 2 = 4$$

__n = 2__

$$y(2) = \sum_{0}^{2} x(K)\, h(2-K)$$

$$= x(0)\, h(2) + x(1)\, h(1) + x(2)\, h(0)$$

$$= -1 + 4 - 1 = 2$$

__n=3__ $y(3) = \sum_{1}^{2} x(K)\, h(3-K)$

$$= x(1)\, h(2) + x(2)\, h(1) = -2 - 2 = -4$$

$\underline{n=4}$

$$y(4) = \sum_{2}^{2} x(K)\, h(4-K)$$

$$= x(2)\, h(2) = 1$$

$$y(5) = \sum x(K)\, h(n-K) = 0$$

$$y = \{1, 4, 2, -4, 1\}$$

$$X_{min} + h_{min} \leq n \leq X_{max} + h_{max}$$

$*$ $y(n) = x(n) + 0.5\, x(n-1) + 0.25\, x(n-2)$

from step input find $y(n)$ using Convolution

$\underline{n=0}$ $y(0) = x(0) + 0.5\, x(-1) + 0.25\, x(-2)$

$$= x(0) = 1$$

$\underline{n=1}$ $y(1) = x(1) + 0.5\, x(0) + 0.25\, x(-1)$

$$= 1 + 0.5 = 1.5$$

$\underline{n=2}$ $y(2) = x(2) + 0.5\, x(1) + 0.25\, x(0)$

$$= 1.75$$

$$y(n) = \sum h(n-K)$$

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